



IMPACT AND PROCESS EVALUATION OF AMEREN ILLINOIS COMPANY'S RESIDENTIAL HVAC PROGRAM (PY4)

Final

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1. EXECUTIVE SUMMARY

Ameren Illinois Company's (AIC's) Heating and Air Conditioning Program (HVAC Program) offers customer incentives for the purchase of high-efficiency furnaces, boilers, air source heat pumps (ASHP), ground source heat pumps (GSHPs), or central air conditioners (CACs), all of which must be installed by an HVAC Registered Program Ally. Incentive levels vary according to equipment type and existing efficiency levels. Overall, the expected savings from this program were 5% of the overall PY4 portfolio of electric savings and 23% of PY4 portfolio therm savings.

This report addresses AIC's fourth program year, which covered the period of June 1, 2011 through May 31, 2012. To support the evaluation, we conducted participant satisfaction surveys and measure installation verification through phone interviews, site visits, and a review of program rebate invoices. Additionally, the team began installing meters in PY4, which will provide information for updating per-unit savings estimates for PY6. In particular, the meter data will provide total unit energy consumption, peak demand, and heating and cooling cycle times and backup heat use.

Impact Results

Our assessment of the HVAC Program indicates that program tracking is accurately capturing the number of program participants and program savings. Table 1 shows the number of program participants by measure type and the number of verified measures listed for site visits, phone surveys, and document reviews. Only the document reviews affected the overall verification rate. Our review found that one air source heat pump measure should have claimed higher savings. Due to limited sample size, we applied verification results to all electric measures combined (CACs, ASHPs, and GSHPs).

Table 1. Summary of Program Verification Results

Measure	Program Participation (n)	Verified Participants: Site Visits and Phone Survey	Verified Measures – Document Review ^a	Ex Ante Per Unit Savings Value	Verified Energy Savings/Ex Ante Sample Savings - Document Review	Verification Rate
Gas Furnace installations (92/95 AFUE)	5,526	50/50	43/43	146 therms (92 AFUE) 171 therms (95 AFUE)	$\frac{7,228 \text{ therms}}{7,228 \text{ therms}} = 1.0$	1.00
Gas Boilers ^d	75	N/A	N/A	230 therms	N/A	N/A
ASHPs	419	59/59	1/2 ^e	373 to 6,071 kWh ^b	$\frac{46 \text{ MWh}}{44 \text{ MWh}} = 1.05$	1.05 ^c
CACs	4,083	59/59	24/24	373 to 1,928 kWh ^b		
Ground Source Heat Pumps	153	N/A	1/1	3,151 kWh		

^a Verification rate for electric measures is based on verified kWh Savings for ASHPs, CACs, and GSHPs combined, not the ratio of documents reviewed.

^b Range of savings shown. Savings vary by equipment efficiency and baseline efficiency.

^c Demand verification rate was calculated in the same way and is 1.03. Energy verification rate is different than demand verification rate because demand savings are only counted for summer, while energy savings is year round.

^d The team assumed a verification rate of 1.0 for this measure.

^e 1 of 2 projects had verified savings equal to tracking database, the other project had higher savings than posted in the tracking database.

Table 2 shows total program net impacts. The 1.05 verification rate for electric measures increases the reported savings. As specified by the NTG framework which is provided in the Illinois Commerce Commission (ICC) Order for Docket 10-0568, the evaluation team estimated net savings using PY3 net-to-gross ratios (NTGRs) of 0.59 for electric measures (ASHPs, CACs, and GSHPs), 1.02 for gas furnaces and 1.01 for gas boilers.

Table 3. PY4 HVAC Program Net Impacts

Program	NTGR	Ex Ante Net Savings			Ex Post ^a Net Savings		
		MW	MWh	Therms	MW	MWh	Therms
ASHP	0.59	0.17	227	0	0.18	239	0
ASHP Early Replacement	0.59	0.71	970	0	0.73	1,018	0
CAC	0.59	0.18	247	0	0.19	260	0
CAC Early Replacement	0.59	2.31	3,146	0	2.37	3,303	0
Ground Source Heat Pump	0.59	0.02	178	0	0.02	187	0
Gas Furnace	1.02	0	0	952,140	0	0	952,140
Gas Boiler	1.01	0	0	17,423	0	0	17,423
Total		3.39	4,769	969,563	3.48	5,007	969,563
		<i>Net Realization Rate</i>			3	1.05	1.00

^a Ex post results are based on a review of the program tracking database and participant invoices.

Process Results

The process evaluation included two research tasks: staff interviews, which helped the evaluation team to better understand the residential HVAC program and its operations; and a customer satisfaction survey. Based on these data collection efforts, we determined that the program, as designed, operates effectively and customers are satisfied with the incentives. While PY4 participation dropped from PY3 levels, the drop may be the result of the phase-out of federal tax incentives.

The evaluation team has two recommendations for AIC to consider that may improve HVAC program success:

- **Emphasize On Bill Financing (OBF).** OBF is a new residential energy-efficiency loan program starting in PY5 that AIC should emphasize in marketing materials that customers see when deciding on equipment replacement. AIC's OBF offering as a way for customers to overcome the high first cost barrier. AIC staff report that many HVAC program participants are taking advantage of the OBF offering in PY5, which allows them to repay the loan they take out for the HVAC equipment on their utility bill. Further, a recent California evaluation of OBF indicated that the majority of loan program participants would not have participated without the program. When combined with the HVAC program's early replacement incentive, OBF offers homeowners an opportunity to affordably replace their inefficient HVAC systems with high-efficiency systems and with no upfront cost barrier.
- **Consider Quality Installation (QI).** Promote quality installation practices to maximize energy savings. Most other utilities with HVAC programs require or incentivize QI practices; however, actual savings are difficult to quantify. The evaluation team will use PY5 site visit and metering data to assess the opportunity to increase savings through QI.

2. INTRODUCTION

This report presents the findings of the PY4 evaluation of the HVAC Program. CSG implements AIC's HVAC program, which offers incentives for the purchase of high-efficiency furnaces, boilers, ASHPs, GSHPs, or CACs installed by an HVAC Registered Program Ally. Applicable federal equipment standards serve as baseline efficiency conditions for new heating and cooling systems.

Incentive levels vary according to equipment types and efficiency levels of existing equipment and AIC customers receive an incentive for the installation of new equipment. The incentive is intended to persuade customers to purchase more efficient equipment than they might otherwise install.

The program also includes an early replacement incentive aimed at customers with operating, but inefficient equipment. Through this offering, the program encourages customers to retire equipment for newer, more efficient units. Incentives pass from HVAC contractors to consumers, and the incentive shows up as a line-item deduction on contractors' installation invoices. Table 4 shows incentives available for the HVAC and Warm Neighbors Cool Friends (WNCF)¹ Programs in PY4.

¹ WNCF offers HVAC incentives specifically targeted at moderate income populations. WNCF participants receive the same HVAC incentives as this program and are counted in total savings estimates; however, the remaining program elements are covered in a separate evaluation.

Table 4. Incentive Amounts for HVAC Program

Action	Incentive	Details
Air Source Heat Pump (ASHP) < SEER*16 replaces greater than SEER10	\$110	New efficient equipment installation.
Air Source Heat Pump, SEER16+ replaces SEER greater than SEER10	\$200	New efficient equipment installation.
Air Source Heat Pump, SEER14.5 replaces SEER less than SEER10 (early replacement)	\$400	Replacing a working CAC or ASHP with a SEER of 10 or less with a new efficient unit.
Air Source Heat Pump < SEER16 replaces SEER less than SEER10 (early replacement)	\$600	Replacing a working CAC or ASHP with a SEER of 10 or less with a new efficient unit.
GSHP Heating and Cooling	\$600	Installing a new GSHP.
Central AC, SEER14.5 replaces greater than SEER10	\$100	New efficient equipment installation.
Central AC, SEER16+ replaces SEER greater than SEER10	\$125	New efficient equipment installation.
Central AC, SEER14.5 replaces SEER less than SEER10 (Early Replacement)	\$250	Replacing a working CAC with a SEER of 10 or less with a new efficient unit.
Central AC < SEER16 replaces SEER less than SEER10 (Early Replacement)	\$350	Replacing a working CAC with a SEER of 10 or less with a new efficient unit.
New Gas Furnace (95% AFUE)	\$200	Installing a new gas furnace with Department of Energy annual fuel utilization efficiency (AFUE) rating of 95% or greater.
New Gas Furnace (92% AFUE)	\$125	Installing a new gas furnace with an AFUE rating of 92% or greater.
New Gas Boiler (90% AFUE)	\$500	Installing a new gas boiler with an AFUE rating of 90% or greater.

*Seasonal, energy-efficiency rating.

AIC began offering HVAC incentives in June 2009. The program has since recruited 811 heating and cooling contractors, 450 of whom are currently active.

During PY4, CSG and AIC marketed the program through direct mailings to customers and through utility bill inserts. In addition, they continued to use the established heating and cooling marketing networks. CSG hosted informational meetings and participated in regional trade shows to increase visibility, and supplied contractors with marketing materials and brochures. To become a Registered Program Ally, contractors must submit insurance documentation and W-9 forms.

3. EVALUATION METHODS

3.1 DATA SOURCES AND ANALYTICAL METHODS

The assessment of the PY4 HVAC Program included both process and impact analyses. Table 5 summarizes research activities informing the evaluation.

Table 5. Summary of Evaluation Methods

Task	PY4 Impact	PY4 Process	Forward Looking	Details
Program staff in-depth interviews		√	√	Interviewed Ameren Illinois and CSG managers to understand program changes from PY3, along with successes, challenges, and progress.
Participant survey	√	√	√	Interviewed participants to verify installation, and to assess program satisfaction
Site Visits	√		√	Verified equipment installation and installed meters (data will become available and an analysis will be conducted in PY5).
Document review	√			Reviewed rebate applications to verify tracking database information.
Database analysis	√	√		Summarized database information to determine program participation and develop key statistics about the program.

3.1.1 PROCESS ANALYSIS

The evaluation team analyzed program materials and used information gathered from stakeholder interviews to understand processes and to identify improvement opportunities. The HVAC Implementation Model (shown in Appendix C) documents program implementation. Data gathered from the participant survey aided in assessing how customers heard about the program and how satisfied they are with the program.

Stakeholder Interviews

To assess the program's effectiveness and implementation, the evaluation team conducted interviews with AIC's program manager, CSG's HVAC implementation manager, and CSG's program director. Stakeholder interviews addressed the program's design, implementation and delivery, marketing efforts, implementation barriers, and communications.

Participant Survey

In May 2012, telephone surveyors contacted 70 customers who had purchased new HVAC products offered through the program during PY4. Surveys verified program participation and product installation. The surveys also assessed participants' satisfaction with the program; which contractors they used; and the incentives they received. By selecting this sample size, the evaluation team sought to produce performance metric estimates at the 90% confidence and ±10% precision levels

for the overall program.

Database Analysis

CSG tracks retail sales of efficient products using a database that ties payment requests to identified transactions, and tracks the following:

- Program activity by product or product type;
- Program activity on an aggregated basis of products incented and dollars spent; and
- Program activity by various identified components (e.g., by product, fuel type, month).

The evaluation team reviewed the database energy savings assumptions and summarized and analyzed the transactions to compute relevant totals for PY4.

3.1.2 IMPACT ANALYSIS

Document Review

To verify savings, the evaluation team selected a random sample of 70 program participants for file review, composed of 27 electric and 43 gas customers. Each electric customer application (either heat pump [HP] or CAC) required an AHRI² certificate to receive an incentive. The evaluation team searched for AHRI numbers in the online database to identify those that did not match the equipment specified on the rebate application or to confirm the legitimacy of the certificate. If we did not find the certificate, the measure would not qualify for a rebate. Table 6 shows the number of samples chosen from each measure type.

Table 6. Completed Document Reviews

Measure Type	Projects	Document Reviews
Central AC	4,083	24
Air Source/ Ground Source Heat Pump	572	3
Gas Furnace	5,786	43
Total*	10,539	70

*Total includes measures listed and measures not receiving document reviews: boilers and Visa Incentives.

We reviewed gas furnace documentation by comparing the furnace nameplate efficiency (AFUE³) to the equipment efficiency reported.⁴

² Air Conditioning, Heating, and Refrigeration Institute.

³ Annual Fuel Utilization Efficiency.

⁴ Deemed savings are either 146 therms for 92 AFUE or 171 therms for 95 AFUE.

Site Visits

The evaluation team conducted 48 site visits in May 2012, installing meters to collect data for the PY5 evaluation. During the visits, technicians installed electric power meters on new cooling units and on some heating units. The evaluation team will also collect energy use data from ASHPs and gas furnaces during the heating season to calculate heating consumption. While conducting site visits to install meters, the evaluation team verified an additional 24 CACs, 24 HPs, and 20 gas furnaces. The customer telephone surveys (n=70) also provided verbal verification that measures had been installed.

The evaluation team calculated the verification rates for gas and electric measures separately. The following equation allowed development of a realization rate from the document reviews and site visits:

$$\text{Verification Rate} = \% \text{ Eligibility} \times \text{Savings Adjustment \%} \times \text{Field and Phone Verification Rate}$$

Where:

% Eligibility: the percentage of verified eligible incentives relative to incentives reviewed (either by AFUE for gas furnaces or Seasonal Energy Efficiency Ratio (SEER) for electric systems).

Savings Adjustment %: the percentage resulting from increases or decreases in savings if systems had AFUE or SEER ratings different from claimed ratings (assessed through document reviews).

% Field and Phone Verification: the percentage of systems verified through site visits and through satisfaction survey phone calls.

The evaluation used unit savings from the PY3 evaluation, together with verified PY4 installation and tracking data, to estimate gross energy and demand impacts. The PY3 unit savings (used to derive gross impacts), were based on site visits, building simulation models, and metering studies completed during the PY3 evaluation cycle.

Net Impacts

Given that the PY4 evaluation did not include NTG analysis, the team applied the PY3 NTGR⁵ to calculate the program's net impacts. The PY3 evaluation study estimated net impacts attributable to the HVAC program through surveys with participating contractors, dropout contractors, and participants.

3.2 SAMPLING AND SURVEY COMPLETES

The following sections summarize the sampling approach and the telephone surveys, document reviews, and on-site verifications that were completed. Each of these verification activities was

⁵ As specified by the NTG framework which is provided in the ICC Order for Docket 10-0568, the net savings are estimated using NTGRs of 0.59 for electric measures (ASHPs, CACs, and GSHPs), 1.02 for furnaces, and 1.01 for boilers.

conducted separately (e.g., telephone surveys, site visits, and document reviews all used different participants).

3.2.1 TELEPHONE SURVEYS

The evaluation team used telephone surveys to assess program satisfaction and to recruit customers for a metering study.⁶ The survey used a sample size of 70 electric (HP or CAC) participants to meet the 90/10 precision threshold overall, which was split evenly between heat pumps and CACs.

Forty-three percent of the chosen sample also participated in the gas furnace program. Table 7 shows the number of telephone surveys by project type.

Table 7. Completed HVAC Program Satisfaction Surveys

Measure Type	Rebates	Telephone Surveys
Central AC	4,083	35
Air Source/ Ground Source Heat Pump	572	35
Gas Furnace	5,878	30
Total*	10,539	70**

*Total includes measures listed and measures not receiving satisfaction surveys: boilers and Visa Incentives.

**70 participants were surveyed; 30 also received gas furnace rebates.

Survey Dispositions and Response Rate

The survey response rate is the number of completed interviews divided by the total number of potentially eligible respondents in the sample. We calculated the response rate using the standards and formulas set forth by the American Association for Public Opinion Research (AAPOR).⁷ For various reasons, we were unable to determine the eligibility of all sample units through the survey process and chose to use AAPOR Response Rate 3 (RR3). RR3 includes an estimate of eligibility for these unknown sample units. The formulas used to calculate RR3 are presented below. The definitions of the letters used in the formulas are displayed in the Survey Disposition tables below.

$$E = (I + R + NC) / (I + R + NC + e)$$

$$RR3 = I / ((I + R + NC) + (E*U))$$

We also calculated a cooperation rate, which is the number of completed interviews divided by the total number of eligible sample units actually contacted. In essence, the cooperation rate gives the

⁶ The satisfaction survey was unable to recruit all the required metering participants. Therefore, Cadmus engineers called a random sample of program participants to explain the meter installation and recruit metering study participants.

⁷ *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*, AAPOR, 2011. http://www.aapor.org/AM/Template.cfm?Section=Standard_Definitions2&Template=/CM/ContentDisplay.cfm&ContentID=3156

percentage of participants who completed an interview out of all of the participants with whom we actually spoke. We used AAPOR Cooperation Rate 1 (COOP1), which is calculated as:

$$\text{COOP1} = I / (I + R)$$

The approach to calculating response rates differs slightly for Internet based surveys. In these instances, the survey response rate is the number of completed surveys divided by the total number of potentially eligible respondents in the sample. The quality of the email list is a key factor in determining the eligibility of participants who do not respond to the email but also do not bounce back. This calculation assumes a high-quality list in which all respondents are eligible except those who reply with an accepted reason why they are not eligible (e.g., employee of client).

We fielded the survey with HVAC participants from April 19–April 27, 2012. Table 8 shows the final survey dispositions.

Table 8. HVAC Survey Dispositions

Disposition	N
Completed Interviews (I)	99
Eligible Non-Interviews	331
<i>Refusals (R)</i>	243
<i>Mid-Interview terminate (R)</i>	17
<i>Respondent never available (NC)</i>	70
<i>Language Problem (NC)</i>	1
Not Eligible (e)	248
<i>Fax/Data Line</i>	9
<i>Non-Working</i>	124
<i>Wrong Number</i>	27
<i>Business/Government</i>	16
<i>Cell Phone</i>	1
<i>No Eligible Respondent</i>	71
Unknown Eligibility Non-Interview (U)	433
<i>Not Attempted</i>	46
<i>No Answer</i>	181
<i>Answering Machine</i>	204
<i>Busy</i>	2
Total Participants in Sample	1,111

The following table provides the response and cooperation rates.

Table 9. HVAC Survey Response and Cooperation Rates

AAPOR Rate	Percentage
Response Rate (RR3)	14%
Cooperation Rate	28%

3.2.2 ON-SITE VERIFICATION

The evaluation team selected a simple random sample of 24 CACs and 24 ASHPs for metering, which began in PY4 and will continue into PY5.⁸ Twenty of the 48 CAC and heat pump participants also received gas furnace installation incentives. Table 10 shows the metering disposition. The results of the metering study are intended to be used for updating the Illinois Technical Reference Manual and will be reported in PY5.

Table 10. Site Visit Sampling Approach

Sampling Strata	Number of PY4 Rebates	Site Visit Sample to Date	Site Visits Completed to Date
CACs	4,083	24	24
Air Source Heat Pumps	419	24	24
Gas Furnaces	5,878	0	20
Total	10,539	48	68

*Total includes measures listed as well as measures not receiving site visit: boilers and Visa Incentives, and ground source heat pumps.

The final sample design provides statistically valid verification results at 90% confidence and $\pm 10\%$ precision levels for the HVAC program.

⁸ We will visit an additional 28 furnaces in PY5 for a total of 48.

4. RESULTS AND FINDINGS

4.1 PROCESS FINDINGS

4.1.1 PARTICIPATION TRENDS

AIC provided 11,939 electric incentives in PY3, compared to 4,661 in PY4. Similarly, AIC provided 8,995 gas incentives in PY3, compared to 5,878 in PY4. Figure 1 shows the PY4 monthly participation by gas measure. The majority of measures are 95 AFUE furnaces. Program purchases appear to peak twice a year, during June and November. Figure 2 shows the PY4 monthly participation for electric measures. Participation peaks in June, mostly due to central air conditioning measure installation. Figure 3 shows the overall HVAC program participation throughout PY4. Overall participation peaked in June and was at its lowest point in February.

Figure 1. PY4 Monthly Participation - Gas

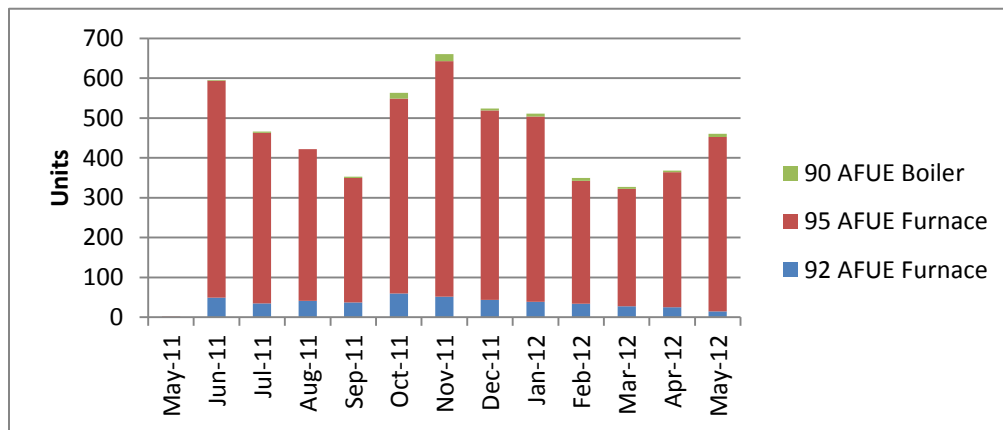


Figure 2. PY4 Monthly Participation - Electric

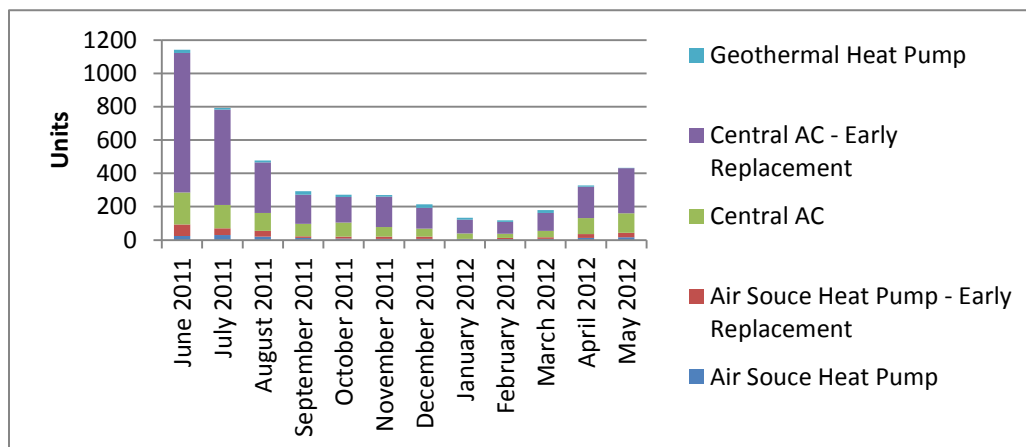
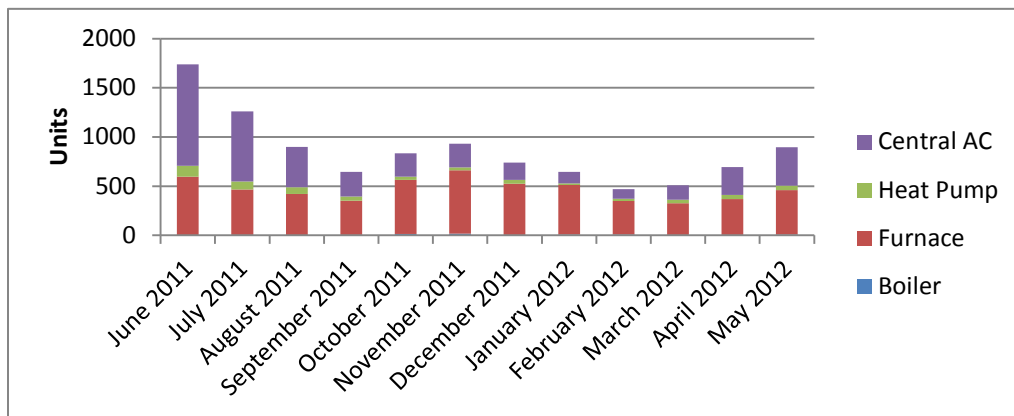


Figure 3. PY4 Monthly HVAC Program Participation



4.1.2 PROGRAM AWARENESS AND SATISFACTION

Customers who participated in the residential HVAC program expressed satisfaction with trade ally interactions and the installation process. Customers primarily learned about the program through trade allies; 83% of customers indicated they learned about the program through means involving contractors. Figure 4 summarizes how customers learned of the program. Figure 5 compares AIC's PY3 and PY4 program awareness levels to those of other utility programs. AIC's PY4 program has the highest percentage of program awareness occurring through contractors.

Figure 4. Program Awareness

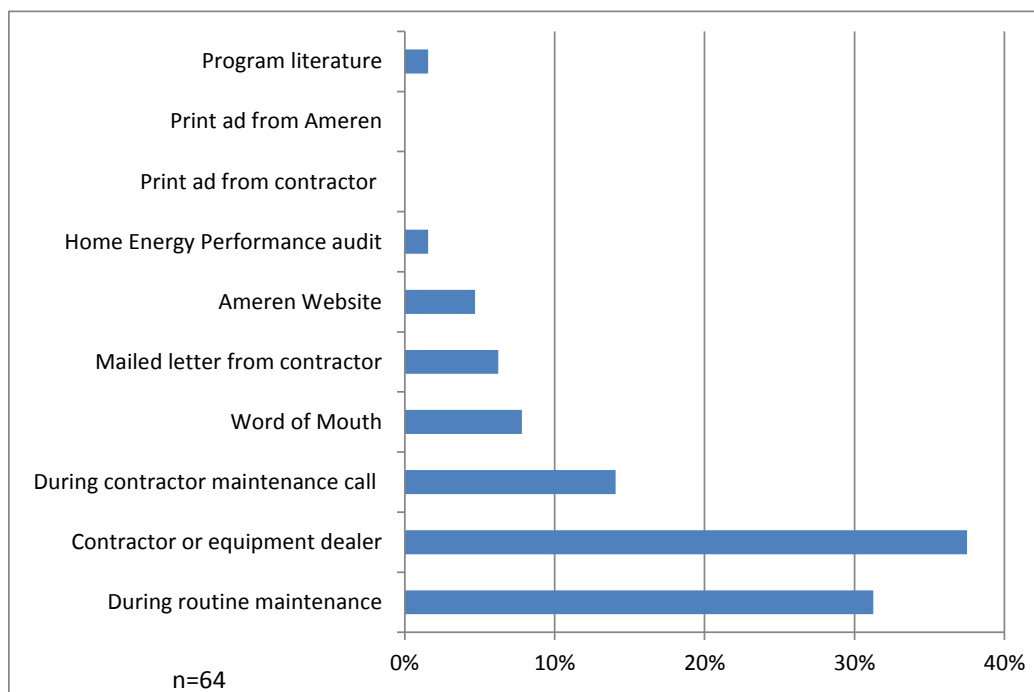
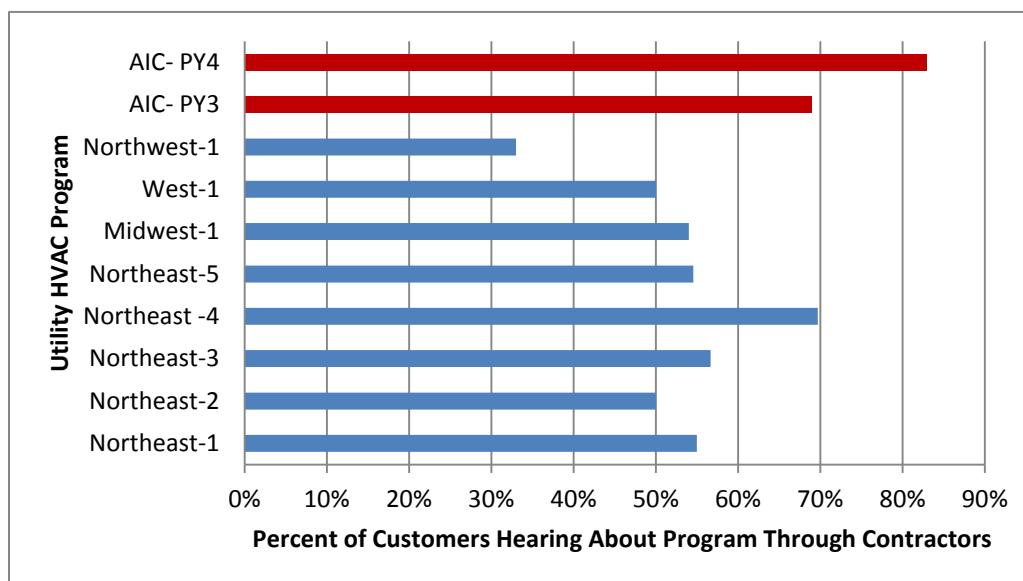


Figure 5. Comparison of Program Awareness

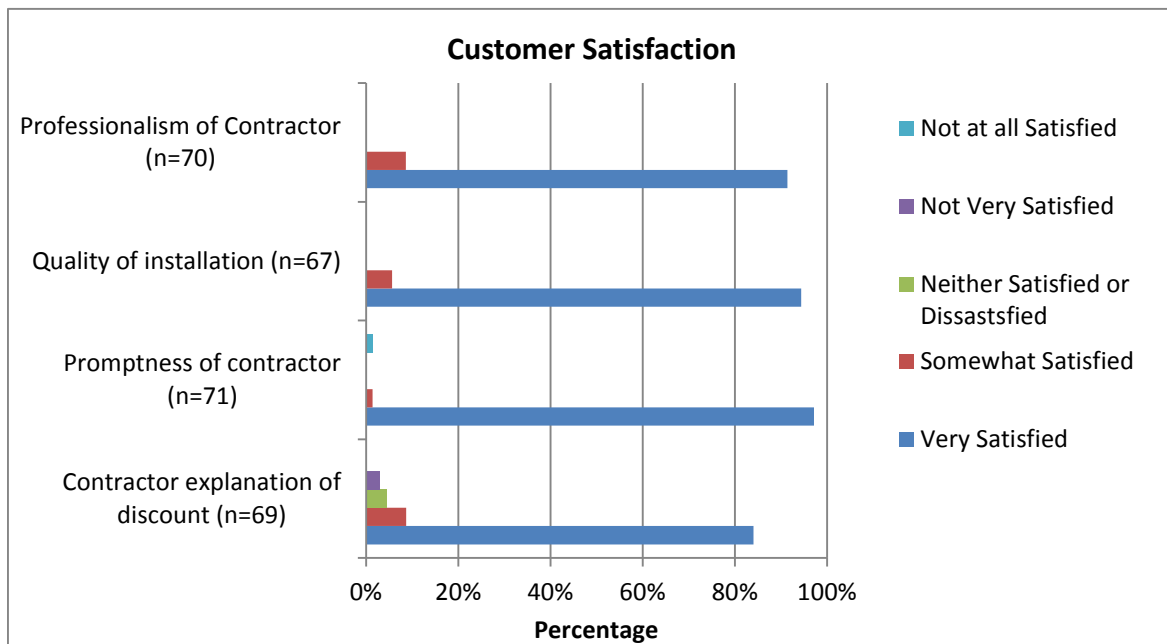


Source: Cadmus database of Residential HVAC program evaluations.

Program staff reports that the program currently has 811 registered trade allies, of whom 450 are active (meaning they submitted an application during the last six months). Trade allies play a critical role in the program, since most installations come through direct trade ally sales. Stakeholders expressed satisfaction with trade allies, characterizing communications and relations as good. As shown in Figure 6, surveyed customers also expressed strong satisfaction with trade allies.

The surveys asked customers to provide suggestions about how contractors could better explain the HVAC program incentives. Four of the five participants who provided responses stated the contractor could have provided more detailed explanations about the program's nature and how it would impact them. The remaining respondent stated the contractor took the informational materials explaining the program and never returned them.

Figure 6. Customer Satisfaction with Trade Allies



As shown in Figure 7, 80% of heat pumps and 92% of central air conditioning (AC) units were early replacements while the remaining were replaced on burnout. Of 32 customers with AC units, 36% of respondents (14 of 39) indicated their AC unit replaced one that still worked⁹, as shown in Figure 8.¹⁰ Of customers replacing heat pumps, 21% (four of 19) stated the rebated heat pump replaced units still working, as shown in Figure 9.

⁹ The team acknowledges that the term “working” or “worked at all” is subjective and that the unit may have been operable, but not working to satisfaction. The program requires a contractor to specify whether the unit qualifies for the early replacement incentives and may differ from the homeowner’s definition of whether or not the unit works. CSG also performs a quality assurance review of a sample of units prior to approving the incentives.

¹⁰ Early replacement units receive a much higher incentive than units replaced on burnout.

Figure 7. Early Replacement Units

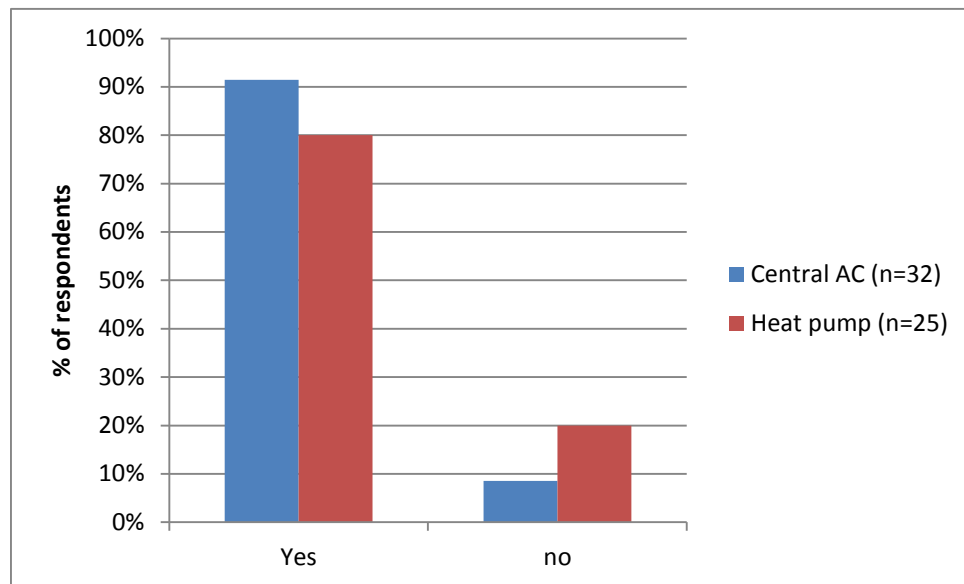
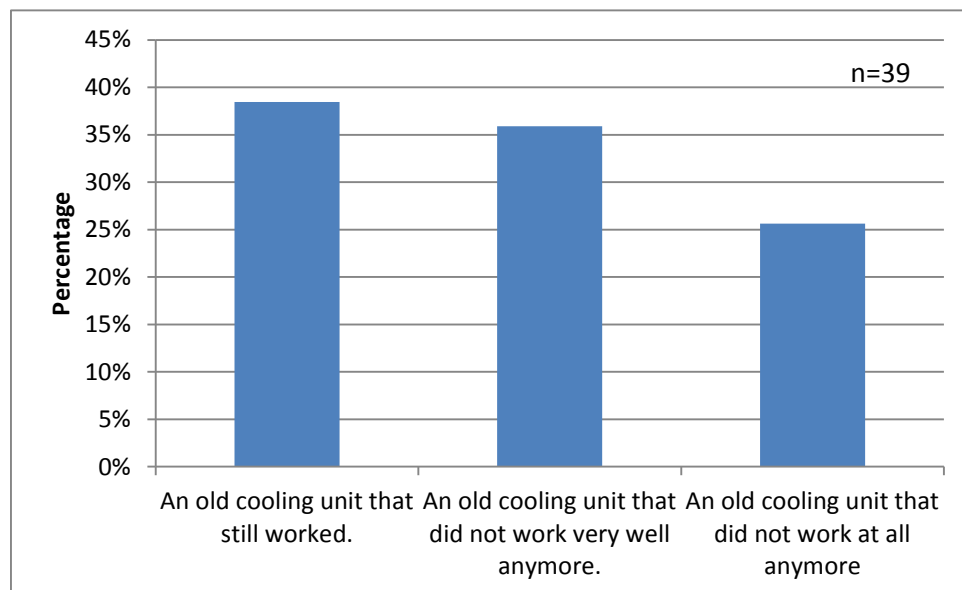
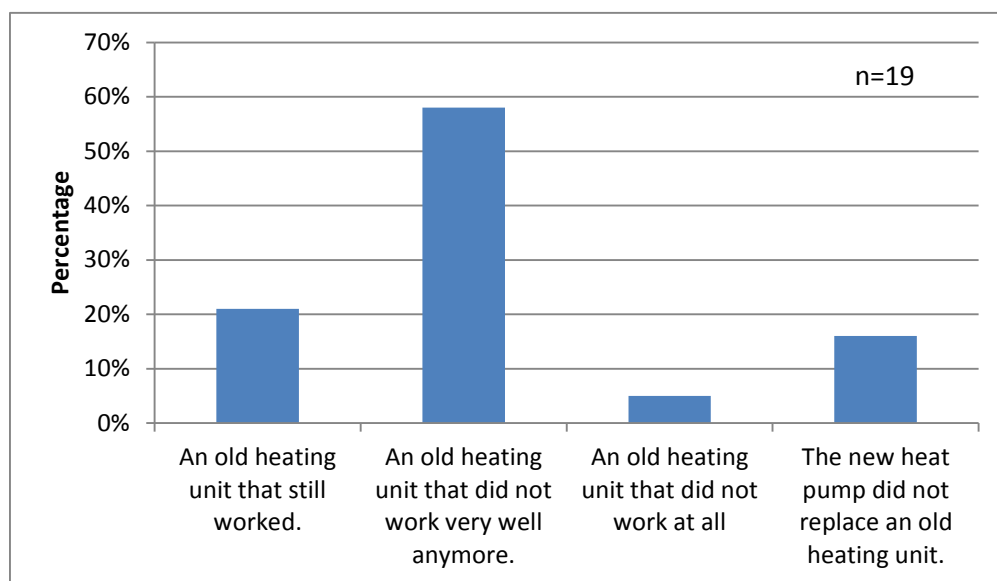


Figure 8. AC Replacement



Note: Program requirements for early replacement may be different that the customer's perception of whether or not the unit still worked.

Figure 9. Heat Pump Replacement



Note: Program requirements for early replacement may be different than the customer's definition of whether or not the unit still worked. The last column may have been an ASHP replacing an AC unit.

4.1.3 MARKET EFFECTS

Stakeholder interviews and participant surveys clearly highlight that trade allies are critical to program success. Stakeholders report that the market is changing slowly; when the program increased the minimum efficiency level for which it offers incentives to 14.5 SEER in PY4, fewer customers purchased program-qualifying equipment.

Anecdotally, program staff has heard that more customers are purchasing 13 SEER models than in previous years. And while the program did not meet its PY4 sales targets, that performance seems to be consistent with national trends. Overall, HVAC sales fell this past year, possibly because of the change in federal tax incentives. In addition, the continued slow economy may also affect sales; anecdotal reports from trade allies indicate that some customers chose to repair or purchase less expensive (and less efficient) equipment.

Moving forward, primary program goals include increasing awareness and education among trade allies and contractors. Program staff also are considering including a QI component in the program. Contractors who have a better knowledge of the program and who ensure that installations meet standard guidelines, combined with an effective rebate and refined marketing, could begin transforming the market toward high-efficiency products.

4.1.4 MARKETING ON BILL FINANCING TO HELP CUSTOMERS OVERCOME BARRIERS

Many of the stakeholders interviewed believe that the economic downturn, combined with the end of the federal incentives, may have reduced HVAC program participation. AIC staff report that many HVAC program participants are taking advantage of AIC's new OBF offering in PY5, which allows them to repay the loan they take out for the HVAC equipment on their utility bill. Research in other regions suggests OBF was necessary for participation in similar HVAC rebate programs.¹¹ The majority of loan program participants surveyed (72%)¹² said they would not have completed an energy-efficiency project if OBF were not available. Ninety-one percent of participants surveyed said the ability to make loan payments through the utility bill was a valuable feature. When combined with the HVAC program's early replacement incentive, OBF offers homeowners an opportunity to affordably replace their inefficient HVAC systems with high-efficiency systems and with no upfront cost barrier. AIC should place a greater emphasis on these two points in its marketing materials.

4.1.5 QUALITY INSTALLATION

AIC does not require test data or installation protocols for new equipment installation. Not requiring this data makes it easier for more contractors to participate in the program than might otherwise do so. In our research in other regions, contractors who are participating in QI programs have indicated that rigorous requirements often discourage participation.

Still, QI standards remain important and ensure HVAC systems operate as expected. QI savings can be difficult to quantify because monitoring and verification efforts rely on post-measure installation and secondary data. The evaluation team currently is metering 48 HVAC systems (and will meter an additional 48 gas furnaces) for the PY5 evaluation year. Through our meter data analysis and site visits for meter installs, we will have a good understanding of AIC contractor installation practice quality. Should AIC choose to implement a future QI program, we will be able to quantify the additional energy saved by comparing unit energy consumption (UEC) measured by the current metering study to metered UEC of QI HVAC systems.

The evaluation team has conducted benchmark research on several QI programs. Our research shows that a significant number of HVAC programs do require QI. For example, Ameren Missouri requires contractors to report pre- and post-installation measurement data (HVAC system diagnostic tests) to the program implementer to verify that old systems qualify for early replacement incentives. The same measurements are required after new systems have been installed.

Table 11 lists various QI programs across the nation and the components that are typically involved.

¹¹ Many other programs are grant subsidized and offer zero interest rates. AIC's interest rate is 4.99%.

¹² California 2010-2012 On-Bill Financing Process Evaluation and Market Assessment. CALMAC ID#:CPU0056.01

Table 11. Various Utility Quality Installation Requirements

Utility	QI Required?	QI Component(s)
Xcel Energy; Colorado	Yes	<ul style="list-style-type: none"> • Load calculation and proper equipment sizing. • Correct airflow level. • Correct refrigerant charge level. • Duct sealing.
Arizona Public Service; Arizona	Yes	<ul style="list-style-type: none"> • Load calculation and proper equipment sizing. • Correct airflow level. • Correct refrigerant charge level.
Connecticut Light & Power, The United Illuminating Company; Connecticut	No	<p>QI is optional, but if done must include all of the following components:</p> <ul style="list-style-type: none"> • Load calculation and proper equipment sizing. • Correct airflow level. • Correct refrigerant charge level. • Duct sealing.
Rocky Mountain Power; Utah	No	<p>The following components are optional:</p> <ul style="list-style-type: none"> • Load calculation and proper equipment sizing. • Correct airflow and refrigerant charge levels. • Duct sealing.
Salt River Project; Arizona	Yes	<ul style="list-style-type: none"> • Load calculation and proper equipment sizing. • Correct airflow level. • Correct refrigerant charge level. • Duct sealing (optional).
San Diego Gas & Electric; California	Yes	<ul style="list-style-type: none"> • Load calculation and proper equipment sizing. • Correct airflow level. • Correct refrigerant charge level. • Duct sealing.
Southern California Edison; California	Yes	<ul style="list-style-type: none"> • Load calculation and proper equipment sizing. • Correct airflow level. • Correct refrigerant charge level. • Duct sealing.

General findings indicate the following:

- Many QI programs collect load calculations and conduct a file review for every installation, as recommended by the ACCA¹³ 9 verification protocol.
- Most QI programs include on-site verification for a sample of installations. Several program sponsors follow a contractor-based tiered sampling protocol, which verifies a higher percentage of installations for contractors new to the program. Once contractors have successfully completed several installations and have proven their QI knowledge, smaller samples of their installations are verified.
- Most programs base desired airflow levels on system design and allow measured airflow to vary within 15% of the design level. Most duct sealing programs require measurement of air

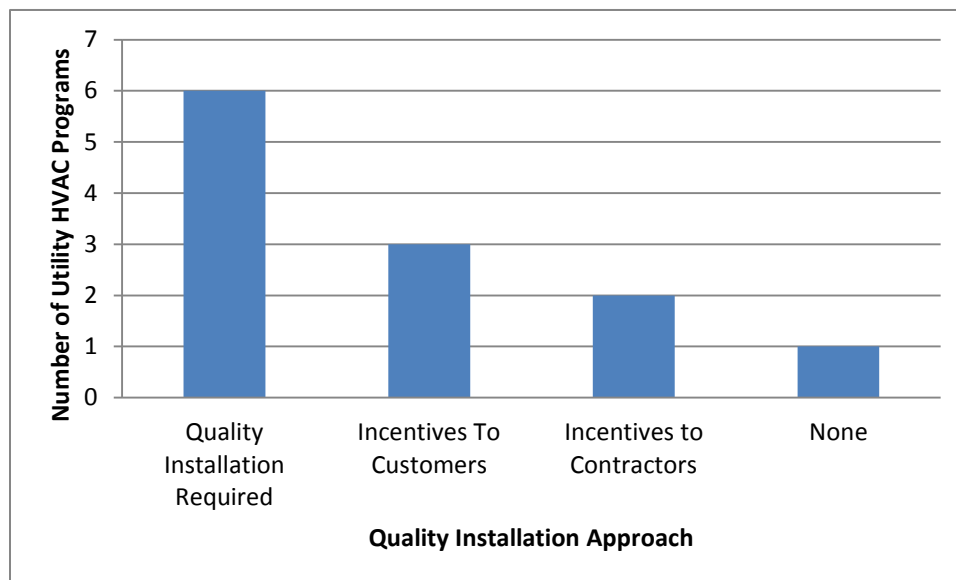
¹³ Air Conditioning Contractors of America.

leakage from ducts; these programs either set a maximum percentage of airflow allowed as leakage or a minimum required leakage reduction. Other programs only require contractors to seal exposed ductwork and alert customers if they identify substantial airflow issues.

- Utilities either use AHRI or Manual S¹⁴ to calculate matched equipment capacity to determine whether systems are sized correctly by comparing to Manual J¹⁵ capacity estimate.

As an alternative to QI requirements, some utilities offer incentives to contractors or to customers for using QI installation practices. As shown in Figure 10, out of 12 other evaluation team clients with HVAC programs only one program administrator does not have QI requirements or incentives.

Figure 10. Number of Utility HVAC Programs with QI Elements



In PY5, the evaluation team plans to analyze the metering data along with information from on-site verifications to assess AIC program participants' system installation quality. We will assess the quality of the installation¹⁶ by measuring refrigerant charge, by measuring the airflow rate, by determining whether the system was sized properly, and by analyzing the backup heat use (control strategy) of heat pumps. If systems do not operate as intended due to poor installation practices, the evaluation team will recommend that AIC consider adding QI as a program requirement. As an example, Table 12 illustrates the efficiency change associated with improper system charging.¹⁷

¹⁴ <http://www.acca.org/Files/?id=67>

¹⁵ <https://www.acca.org/Files/?id=68>

¹⁶ Following ACCA standards for QI:
http://www.energystar.gov/ia/home_improvement/home_contractors/gispec.pdf

¹⁷ Proctor engineering : www.proctoreng.com/checkme/technical.html.
New Buildings Institute, Small HVAC System Design Guide, prepared for the California Energy Commission

Table 12. Refrigerant Charge Level and Air Conditioner Efficiency

Percent Undercharged	Efficiency Loss
0 (properly charged)	0.00
5%	0.04
10%	0.10
15%	0.19
20%	0.28
Percent Overcharged	Efficiency Loss
5%	0.05
10%	0.09
15%	0.11
20%	0.14

ENERGY STAR® claims “typical HVAC systems” use as much as 12% more energy than systems installed with quality installation practices¹⁸.

4.2 **IMPACT RESULTS**

4.2.1 PARTICIPANT VERIFICATION/INSTALLATION RATE

As discussed in Sections 3.1.4 and 3.1.5, the evaluation team reviewed rebate applications and verified measure installation. We searched for AHRI numbers in the online database and verified that all 27 were legitimate numbers. If certificates could not be found in the system, projects would not be eligible for rebates.

We used the following equation to develop a verification rate from the document review and site visits:

$$RR = \% \text{ Eligibility} \times \text{Savings Adjustment \%} \times \text{Field and Phone Verification Rate}$$

Where

% eligibility: the percentage of verified eligible incentives relative to incentives reviewed (either by AFUE for gas furnaces or SEER for electric systems).

Savings adjustment %: resulting from increases or decreases in savings if systems had AFUE or SEER ratings different from claimed ratings (assessed through document reviews).

% Field and phone verification: % of systems verified through site visits and through satisfaction survey phone calls.

Field and telephone verification equaled 100%; all 24 ACs, 24 HPs, and 20 gas furnaces found in the field had been installed as expected, and 100% of surveyed participants confirmed product purchase and installation. The evaluation team found no discrepancies in the gas measure incentive document review; all gas measure savings were claimed correctly.

¹⁸ http://www.energystar.gov/index.cfm?c=hvac_install.hvac_install_index

The evaluation team did discover one electric measure discrepancy during the document review; that discrepancy changed the savings attributable to that measure. Savings increased slightly because the tracking system indicated the measure to be a 14.5 SEER when it actually is 18.6. The incentive and savings claimed for this measure were for a 14 SEER heat pump replacing a system greater than 10 SEER, when the savings claimed should have been for a 16+ SEER heat pump. The result was an increase in the program electric energy savings of 5% for kWh and 3% for kW savings.

The program achieved an overall electric verification rate for energy savings of 105%. All efficiencies reported on invoices matched the tracking database. Similarly, discrepancies did not emerge from site visits. Stratification by measure type did not occur. Table 13 shows results of energy savings adjustments from the document review.

Table 13. Overall HVAC Program Verification Rate

Type	Database Population	Site Visit Verifications			Telephone Verifications			Completed Document Reviews				Overall
		#	# Verified	Verification Rate	#	# Verified	Verification Rate	#	Efficiency Adjust.	Ineligible Certificates	* % Savings Adjust.	Verification Rate
AC	4,083	24	24	100%	35	35	100%	24	+5%	0	+5%	105%
HP	572	24	24	100%	35	35	100%	3	+5%	0	+5%	105%
Furnace	5,526	20	20	100%	30	30	100%	43	0%	N/A	0%	100%

*Verification rate for electric measures is based on verified kWh Savings for ASHPs, CACs, and GSHPs combined, not the ratio of documents reviewed, as shown in Table 1. Verified kW savings results in 103% verification rate.

4.2.2 NET IMPACTS

As specified by the NTG framework which is provided in the ICC Order for Docket 10-0568, the net savings are estimated using NTGRs of 0.59 for electric measures (ASHPs, CACs, and GSHPs), 1.01 for gas furnaces, and 1.02 for gas boilers¹⁹. These values were based on results from the PY3 evaluation. Table 14 shows the program's net impacts.

Table 14. HVAC Program Net Impacts

Measure	NTGR	Ex Ante Net Savings			Ex Post ^a Net Savings		
		MW	MWh	Therms	MW	MWh	Therms
ASHP	0.59	0.16	220	0	0.18	231	0
ASHP Early Replacement	0.59	0.69	938	0	0.73	985	0
CAC	0.59	0.19	261	0	0.19	274	0
CAC Early Replacement	0.59	2.43	3314	0	2.37	3480	0
Ground Source Heat Pump	0.59	0.04	284	0	0.02	299	0
Gas Furnace	1.02	0	0	952,140	0.00	0	952,140
Gas Boiler	1.01	0	0	17,423	0.00	0	17,423
Total		3.51	5,017	969,563	3.48	5,268	969,563
<i>Net Realization Rate</i>						105%	100%

^a Ex post net savings determined by applying verification rate adjustments to ex ante net savings.

4.3 INPUTS FOR FUTURE PROGRAM PLANNING

The PY4 evaluation did not collect new information to update per-unit values or NTGR, but the meters installed this year will provide such information in PY5. That information will then be used to inform the TRM algorithms. The meter data will provide total unit energy consumption, peak demand, and heating and cooling cycle times and backup heat use. Savings are estimated from this data. In addition to energy and demand savings we will assess the quality of the installation of the system. A PY5 participant survey can also be used to estimate NTGR and to update NTGR values for PY7.

¹⁹ PY3 NTGR estimates for all measures include spillover.

A. APPENDIX: DATA COLLECTION INSTRUMENTS

Ameren Illinois Utilities Residential New Heating & Air Conditioning Equipment Program Participant Survey

Hello, my name is _____ from Opinion Dynamics. I'm calling on behalf of Ameren Illinois, your local utility. According to our records, your household recently participated in Ameren's Act On Energy Program and received a rebate for new HVAC equipment. Please be assured this is not a sales call. My questions are for research purposes only.

[READ ONLY IF ASKED WHY] We are only interested in your opinions to help improve our programs, and understand how to assist customers in saving money on their utility bills. Your individual answers will be used by Ameren to evaluate energy-efficiency programs.

Are you the person in your home who knows the most about taking part in Ameren's HVAC Equipment Program?

(IF NOT CORRECT PERSON: May I please speak to the person in your household who knows the most about the program?) (SCHEDULE CALLBACK IF NEEDED)

- Q2. First I want to ask you some general questions about your experience with Ameren's Program. How did you become aware of this program? [Only read list if necessary]
- 01. (During routine maintenance performed by contractor)
 - 02. (During contractor maintenance call because of system issue/problem)
 - 03. (Mailed letter from a home heating and cooling contractor in your area)
 - 04. (The Ameren website)
 - 05. (Through a Home Energy Performance audit)
 - 06. (Another website [SPECIFY])
 - 07. (Word of mouth)
 - 08. (Print advertisement from an HVAC contractor in your area)
 - 09. (Print advertisement from Ameren)
 - 10. (Through a contractor or equipment dealer)
 - 00. (Or some other way [SPECIFY])
 - 98. (Don't Know)
 - 99. (Refused)

Now I have some questions regarding the process of purchasing your new heating or cooling unit for your home.

- Q3. Did the contractor visit your home and inspect the old unit prior to installation of the new unit?
- 1. Yes
 - 2. No
 - 8. (Don't Know)
 - 9. (Refused)

- Q4. Did the contractor explain the Ameren discounts that were available to help you purchase energy efficient HVAC equipment for your home?
1. Yes
 2. No
 8. (Don't know)
 9. (Refused)
- Q5. How satisfied are you with how well the contractor explained the discount you could get for purchasing energy-efficient HVAC equipment for your home? Would you say you are very satisfied, somewhat satisfied, not very satisfied, or not at all satisfied?
1. Very satisfied
 2. Somewhat satisfied
 3. Not very satisfied
 4. Not at all satisfied
 5. (Neither satisfied or dissatisfied) [DO NOT READ]
 8. (Don't Know)
 9. (Refused)
- Q6. Do you have any suggestions to improve the clarity of the contractor's explanations about the Ameren discounts?
1. Yes
 2. No
 8. (Don't know)
 9. (Refused)
- Q7. [READ ONLY IF Q6 = 1]
How could information on the Ameren discounts be more effectively explained and provided?
[RECORD RESPONSE]
- Q8. Was the Ameren discount for energy efficient HVAC equipment clearly listed on the price quote or invoice of your new equipment?
1. Yes
 2. No
 8. (Don't know)
 9. (Refused)
- Q9. How satisfied are you with the promptness of the HVAC contractor in getting back to you and setting up the appointment to install the new HVAC equipment you purchased? [IF NECESSARY: Would you say you are very satisfied, somewhat satisfied, not very satisfied, or not at all satisfied?]
1. Very satisfied
 2. Somewhat satisfied
 3. Not very satisfied
 4. Not at all satisfied
 5. (Neither satisfied or dissatisfied) [DO NOT READ]
 8. (Don't Know)
 9. (Refused)
- Q10. And are you satisfied with the quality of the installation of the new HVAC equipment?
1. Very satisfied
 2. Somewhat satisfied

3. Not very satisfied
4. Not at all satisfied
5. (Neither satisfied or dissatisfied) [DO NOT READ]
8. (Don't Know)
9. (Refused)

Q11. Would you say you are very satisfied, somewhat satisfied, not very satisfied, or not at all satisfied with the professionalism of the HVAC contractor? [If prompted for definition of professionalism, suggest: Were they knowledgeable, courteous, did they clean up, were they helpful explaining the new system or answering questions?]

1. Very satisfied
2. Somewhat satisfied
3. Not very satisfied
4. Not at all satisfied
5. (Neither satisfied or dissatisfied) [DO NOT READ]
8. (Don't Know)
9. (Refused)

[ASK IF Central AC was installed, ELSE SKIP TO Q13A]

Q12a. Did your new central air conditioner replace an existing central air conditioner?

1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF Q12A=1, ELSE SKIP TO Q12B]

Q12. Did the new central air conditioner replace...?

1. An old cooling unit that still worked.
2. An old cooling unit that did not work very well anymore.
3. An old cooling unit that did not work at all anymore.
8. (Don't Know)
9. (Refused)

[ASK IF QA12A DOES NOT =1]

Q12b. Did your new central air conditioner replace an existing room air conditioner?

1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF Q12B=1]

Q12c. Did the new central air conditioner replace...?

1. An old cooling unit that still worked.
2. An old cooling unit that did not work very well anymore.
3. An old cooling unit that did not work at all anymore.
8. (Don't Know)
9. (Refused)

[ASK IF Heat Pump was installed, ELSE SKIP TO INVITATION]

Q13a. Did the new heat pump replace existing cooling equipment?

1. Yes
2. No

- 8. (Don't know)
- 9. (Refused)

[ASK IF Q13A=1]

Q13b. Did the new heat pump replace...?

- 1. An old cooling unit that still worked.
- 2. An old cooling unit that did not work very well anymore.
- 3. An old cooling unit that did not work at all
- 8. (Don't Know)
- 9. (Refused)

Q14a. Did the new heat pump replace existing heating equipment?

- 1. Yes
- 2. No
- 8. (Don't know)
- 9. (Refused)

[ASK IF Q14A=1]

Q14b. Did the new heat pump replace...?

- 4. An old heating unit that still worked.
- 5. An old heating unit that did not work very well anymore.
- 6. An old heating unit that did not work at all
- 7. The new heat pump did not replace an old heating unit.
- 8. (Don't Know)
- 9. (Refused)

INVITATION FOR METERING STUDY

We often like to visit homes and gain a better understanding of the energy savings from the new equipment that was installed. We are offering a \$50 Visa gift card to those who agree to a site visit. The visit would involve an engineer installing metering equipment on your new air conditioning unit and indoor fan. The installation of metering equipment would take about 90 minutes. Are you interested?

IF YES:

Thank you very much for your interest in participating. Let me just verify that I have the correct name, address, and contact information. Someone will contact you shortly to schedule a time to install the energy monitoring equipment.

You will receive a letter with details about the study and to confirm the visit. If you have any questions or concerns and would like to contact your Ameren utility account representative, please call: Sharon Ruhland; sruhland@ameren.com; (309)677-5192

Thanks again for your time, and we look forward to meeting you shortly. Have a good (day/night).

B. APPENDIX: IMPLEMENTATION MODEL

The evaluation team created an implementation model for the Residential HVAC Program that was evaluated in PY4. An implementation model is a graphic presentation of the intervention—what occurs and who undertakes the functional activities of the program.

The model, created in a multi-level Visio format, displays various functions in rows with the key stakeholders and processes in the columns. We determined these functions, stakeholders, and processes by reviewing the available program documentation, which we further refined in interviews with key implementation staff. This model does not attempt to assess the effects of the program.

The model is organized by function and the stakeholders involved.

- **Functions** represent the discrete purposes established by the program. These functions include program design, marketing, customer and program ally education, service delivery, and QA/QC. Service delivery encompasses activities that are directed toward intervention recipients and, as shown in this model, is a catch-all for any activity that does not fit in another function.
- **Stakeholders** are the various providers who are involved in program delivery or those who receive program services. Stakeholders include the customer, the implementer and associated subcontractors, and the utility.

For the Residential HVAC Program, key program functions include:

- **Program Administration and Design:** Utility personnel and implementation staff from CSG work together to establish program goals, budgets, and marketing plans. CSG manages AIC's program portfolio; HVAC program goals and design are also influenced by other programs in the portfolio.
- **Marketing and Outreach:** The majority of CSG's marketing and outreach efforts are designed to provide training and tools that help trade allies to upsell high-efficiency equipment directly to customers while they are on site. Bill inserts and direct mailings are also used to help inform customers about the program.
- **Education:** CSG conducts education events (webinars and in-person trainings) for trade allies to learn about the program and to learn how to effectively market high-efficiency equipment. The training encourages contractors to use industry best practice standards and to achieve certifications such as North American Technician Excellence (NATE). In-depth technical training is not offered and no technical certifications are required.
- **Service Delivery (Customer Facing Activities):** Trade allies install qualifying equipment and must provide a line-item deduction for the incentive to the customer. If the customer receives an early replacement incentive, the trade ally collects existing system information and submits a reservation for the incentive to AIC.
- **Service Delivery (QA/QC and Reporting):** CSG account managers are assigned to and work directly with trade allies. CSG staff track and analyze incentive data to determine whether to change the program design and implementation. CSG also verifies a sample of early replacement rebates by inspecting existing equipment in the field.

- **Service Delivery (Rebates and Incentives):** The customer receives a line-item deduction from the trade ally, the trade ally submits invoices to CSG for payment, and CSG submits invoices to Ameren for work completed and rebates disbursed.

Note: While the program includes “diagnostic and optimization” measures, that program component has not yet begun operating so it is not included in the implementation model.

The HVAC Program Implementation model and key follow.

